

ANNOTATIONES ZOOLOGICAE JAPONENSES

Volume 24, No. 1—December 1950

Published by the Zoological Society of Japan
Zoological Institute, Tokyo University

Clavularia racemosa, a New Primitive Alcyonarian
Found in Japan and Formosa

With 3 Text-figures

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(Communicated by T. KOMAI)

For many years a vast number of species have been described under the genus *Clavularia*, a well-known type of the Stolonifera. There is still, however, considerable doubt as to the natural position of some species, and as to the validity of others. As far as I am aware, only five species of *Clavularia* have hitherto been described from Japan: namely, *C. eburnea*, *C. peterseni*, *C. dispersa* (Kükenthal, 1906a), *C. sulcata* (Nutting, 1912) and *C. gotoi* (Okubo, 1929). All of them are recorded from deep waters, of from 80 to 1200 meters. The form to be described in the present paper is common in the littoral of southern Japan and Formosa. It clearly belongs to this genus, but cannot be referred to any of the described species. I propose to call it *Clavularia racemosa*, n. sp.

SPECIMEN FROM JAPAN

This alcyonarian has a thread-like, anastomosing stolon, usually more than 10 cm long, with numerous polyps arising at short intervals. It grows on the stems and leaves of the kelp *Sargassum patens* Agardh, and appears much like a moss or an ivy.

When fully expanded, the polyp is coloured chocolate brown, owing to the great quantity of zooxanthellae contained in anthocodiae and tentacles. The anthosteles and stolons are paler, being light brown drab, light purple or even whitish due to densely packed spicules. When contracted, the colony takes the colour of stolon and anthosteles. In

spirit or formalin these colours fade away and the colony becomes milky white. Some specimens in spirit are greenish white.

The *stolon* spreads over the twigs of the kelp, and appears threadlike instead of being membranous as in most species of *Clavularia*. The main branch stretches along the axis of the twig of the kelp, and fuses here and there with the neighboring branches by short branchlets (Fig. 1A). The base of the colony which sends out the main branches shows most profuse anastomoses, the branches forming an irregular network of fine meshes, bearing comparatively few polyps.

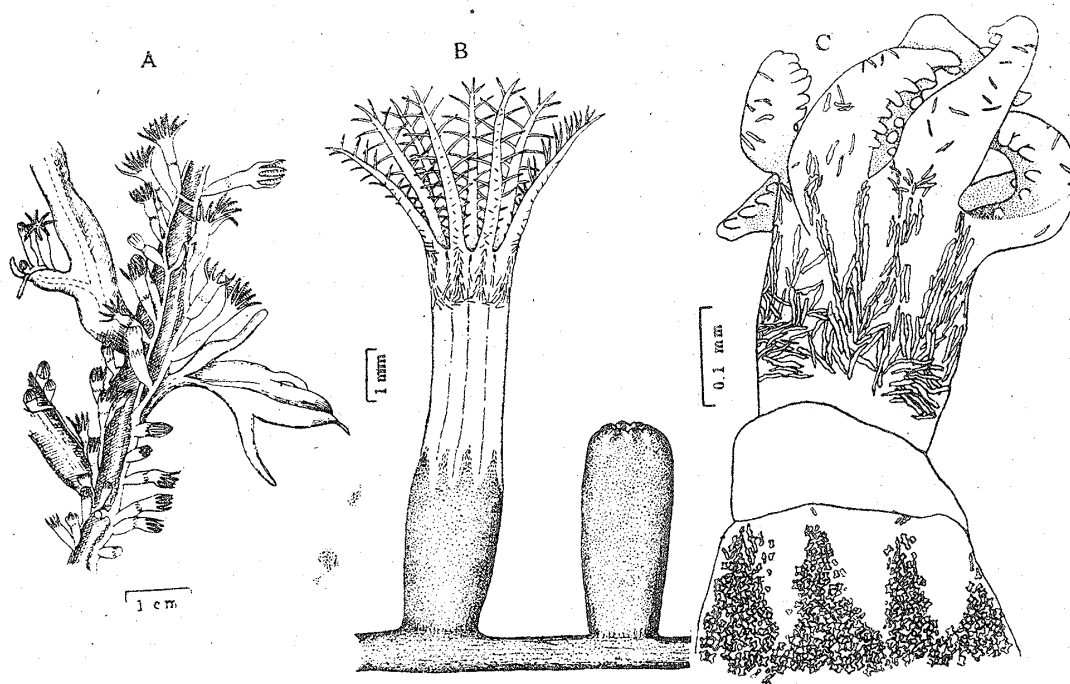


Fig. 1. Colony and polyps of *Clavularia racemosa* n. sp. A, a living colony growing on a twig of *Sargassum*. B, a fully expanded and a completely retracted polyp. C, upper part of partially expanded polyp.

The *stolon* is very thin throughout, about 0.4–1 mm in diameter, and almost circular or semicircular in cross section, although becoming somewhat flattened in the wider places. The points of branching are usually free from polyps.

The *polyps* are closely arranged in one row on the upper surface of the *stolon*, from less than 1 mm to 3 mm apart. In many cases, this distance between the neighboring polyps is much shorter in the proximal and middle parts of the colony than in the terminal part of the *stolon*.

The body of the polyp is distinctly divisible into a proximal densely spiculated anthostele and a distal anthocodia, the latter being completely retractile into the former (Fig. 1B). When fully expanded, the polyps are rather tall, up to 10 mm in height, excluding the tentacles. In a

completely retracted colony, the anthostele forms an elongated cone, measuring about 2–4.5 mm long and 1–1.4 mm broad.

The *anthostele* is thick-walled, opaque, and densely beset with spicules. The distal part of the spiculate region forms a chevroned feature in each intermesenteric region. Capstan-shaped spicules are irregularly arranged and massed throughout the greater part of the anthostele, but a few warty spindles may be found in the eight chevroned apices, arranged vertically.

The *anthocodia* is thin-walled, flexible, translucent, and when fully stretched, it is a little longer than the anthostele, measuring about 5–5.5 mm long and 1–1.5 mm broad at the base of tentacles. The upper one-third to one-fourth of the anthocodia is furnished with a crown of spindle- or rod-shaped spicules. These spicules are regularly arranged *en chevron*, consisting of eight double longitudinal rows, of which the eight rows lying below the bases of the tentacles are wider and comprise more numerous spicules than the other eight rows arranged along the bases of the mesenteries (Fig. 1C). In the lower part of the chevrons, the spicules are somewhat obliquely directed, and they are transversely directed in the basal part. The remaining part of the anthocodia is devoid of spicules, and marked with eight whitish lines along the lines of attachment of the mesenteries, the whitish colour being due to the absence of zooxanthellae.

The *mouth* is slit-like, about 0.3 mm long and lies in the center of a deep peristomial depression. The oral disc is chocolate brown, except along the eight whitish lines of attachment of the mesenteries, as in the rest of the polyp wall.

The *tentacles* are pinnate, long, and gently taper distally. In life they appear brownish and opaque owing to the presence of zooxanthellae. The fully stretched tentacle is about 2.5–3 mm long and 0.5 mm broad at the base. The aboral side of the rachis is furnished with a few small spicules arranged in a zigzag course, numbering 15 to 20 in a single tentacle. The pinnules are slender and finger-shaped, and there are 10 or 11 of them on each side of the tentacles. The pinnules in the middle and distal parts of the tentacle are about 0.8 mm long. They are opaque, densely packed with zooxanthellae in the endoderm and with nematocysts in the periphery, but completely devoid of spicules.

The *spiculation* is very characteristic, and unique to the genus *Clavularia*, clearly differing from that in any other described species. The spicules (Fig. 2) are all colourless, and they may be divided into the following three, or more strictly five, types:—

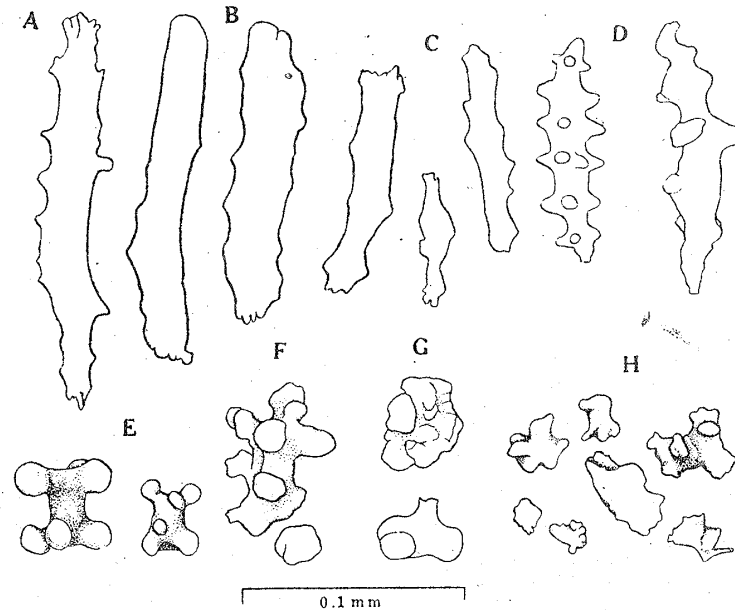


Fig. 2. Spicules of *Clavularia racemosa* n. sp. A, anthocodial rod, on the mesenteric area. B, anthocodial rods, at the base of tentacles on the intermesenteric area. C, rodlets on the aboral side of tentacles. D, warty spindles, from the chevroned apices of anthosteles. E, F, capstans from the anthosteles. G, H, some irregular-shaped spicules from the stolons. (F and G figured from one specimen, the rest from another).

1. Straight or slightly curved and somewhat flattened spindles or rods, covered with a few blunt warts and with the ends bluntly truncated and often jagged.
 - a. The spicules found on the anthocodia, both those horizontally placed and those vertically placed, have the same shape. Average dimensions: 0.2–0.13 mm long and 0.04–0.02 mm wide. (Fig. 2A, B)
 - b. The spicules found on the tentacles are smaller and shorter, being rod-like in young polyps. Average dimensions: 0.12–0.06 mm long and 0.014–0.007 mm wide. (Fig. 2C)
2. Straight and short warty spindles or rods, rather few in number, found on the chevroned apices of the anthosteles. Average dimensions: 0.1–0.05 mm long and 0.014–0.01 mm wide. (Fig. 2D)
3. Capstan-shaped or allied spicules covered with prominent warts.
 - a. Capstans with a distinct median waist and typically three, simply rounded terminal warts, somewhat like the capstans in *Alcyonium*. The greater part of the anthosteles is densely packed with this type of spicule which measures 0.038–0.034 mm long and 0.035 mm wide, including the warts. (Fig. 3E, F)
 - b. The stolon is covered with irregular-shaped spicules, a variety of the capstans of the anthosteles, with an indistinct waist and ir-

regularly lobed warts to a simply rounded sphere. In size these spicules are generally smaller than those of the capstans of the anthosteles (Fig. 2G, H)

Series of thin sections were cut through some decalcified specimens and their structure has been examined (Fig. 3).

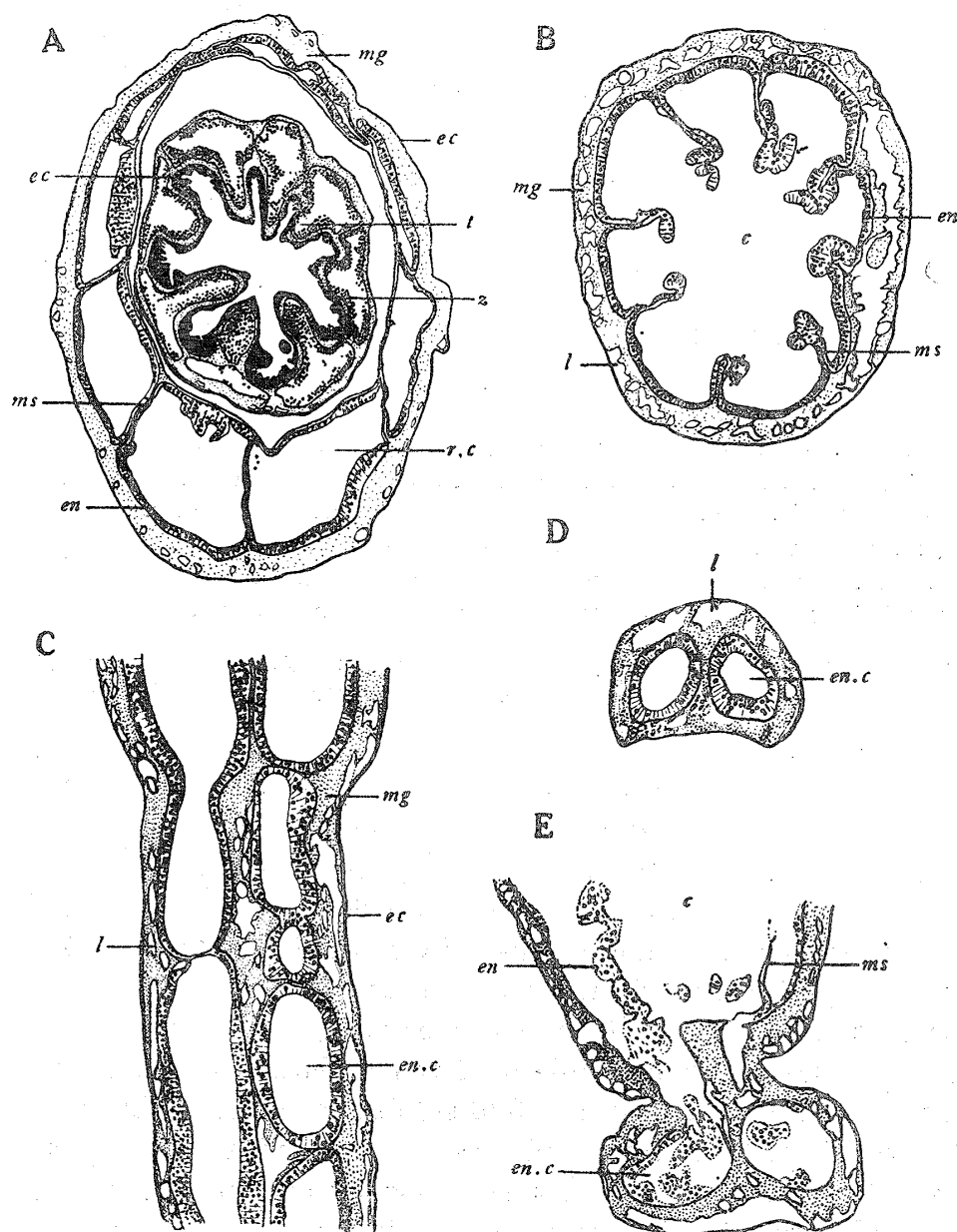


Fig. 3. Internal structure of *Clavularia racemosa* n. sp. A, transverse section of upper part of polyp. $\times 70$. B, transverse section of middle part of polyp, showing the eight mesenterial filaments. $\times 70$. C, horizontal section of stolon. $\times 80$. D, transverse section of stolon. $\times 80$. E, longitudinal section of a polyp-base connected with stolon. $\times 80$. (c coelenteric cavity; ec ectoderm; en.c endodermal canal of stolon; l lacunae of spicules; mg mesogloea; ms mesentery; r. c radial chamber between mesenteries; t retracted tentacle; z zooxanthella.)

The internal structure of the polyps is little worth mentioning. The stomodaeum, which is easily seen from the outside, extends throughout the whole length of the anthocodia, and bears on the ventral side a ciliated siphonoglyphe in the lower one-third. The siphonoglyphe is lined internally by a columnar epithelium with long cilia, about 0.06 mm in height. The eight mesenteries (*ms*) are very thin, consisting of two endodermal layers covering a thin sheet of mesogloea, and in the upper part they are provided with powerful retractor muscles on the ventral surface.

The ectoderm (*ec*) of both the polyp and stolon is weakly developed, and represented only by a very thin cuticular membrane under which no ectodermal cell layer, such as found by Kükenthal (1906b) in *C. chuni*, could be detected, as Molander (1920) also mentions in other species of *Clavularia* (*Cornulariella*). The endoderm (*en*) is comparatively thick and contains zooxanthellae in large quantities. The mesogloea (*mg*) is thicker than the endoderm and nearly homogeneous in appearance. It contains numerous spicules towards the periphery, which after decalcification shows large, irregular lacunar spaces (*l*).

The interior of the stolon is occupied by two large soleniae or endodermal canals (*en.c*) running parallel to each other; these are supported by the mesogloea. The canals are not continuous throughout, but interrupted here and there so as to form a chain of chambers, as in *Cornularia komaii* (Utinomi, 1950). They do not communicate with one another, but each communicates individually with the coelenteric cavity (*c*) of the polyps at the point of attachment. In addition to the solenia there are in some places some endodermal cell strings without lumen, which might be mistaken for capillary tubes, as is also the case with other species of *Clavularia* (*Cornulariella*) (Kükenthal, 1906b; Molander, 1929). Apparently these strings never connect with the above-mentioned solenia or with the coelenteron, and may be absent in the mesogloea of the polyp body (Fig. 3C-E).

Habitat. The stoloniferan in question is commonly found growing around the surface of stems of the brown alga *Sargassum patens* Agardh and probably also of *S. serratifolium* Agardh, which occur very commonly in shallow waters of southern Japan. These algae are often inhabited by various epizoic animals, such as sedentary polychaetes (*Salmacina dysteri*, *Spirorbis foraminosus*), hydroids (*Stylactis*), sponges, encrusting polyzoa, compound ascidians, sedentary foraminiferans, etc. Occasionally hollow polyps are found on the living colonies of this species. Probably the soft parts of the anthocodiae have been eaten by certain small predaceous animals. The above observation was made in Tanabe Bay near the Laboratory, which is the type locality of this new species.

SPECIMEN FROM FORMOSA

A specimen collected by myself from Kizan near Suô, on the north-eastern coast of Formosa during my trip in 1938, is also referable to the same species. The colony was found growing on the root of a green alga, *Caulerpa racemosa* var. *clavifera* Weber van Bosse. According to my field-note, it showed an uniformly brownish colour in the living condition. In spirit this colour is gone, and the animal appears white. The polyps arise perpendicularly at narrow intervals on the upper surface of the threadlike, anastomosing, cylindrical stolons. The contracted polyps, the anthosteles, are about 3–5 mm long and 1–1.7 mm in diameter. This specimen shows peculiar spiculation similar to that of the Japanese form described above.

REMARKS

This is probably the sixth species of *Clavularia* known from Japanese waters. It is quite distinctive, and though approaching most nearly in the form of stolon and in the polyp armature to *C. hicksoni* (Gohar, 1940), may be distinguished from the latter by the peculiarity of the spicules which suggests its closer relation to the Alcyoniidae.

A stoloniferan, figured under the name *Cornularia* sp. in "Illustrated Encyclopedia of the Fauna of Japan", Revised Edition (1947, p. 1563, fig. 4399) shows a very close resemblance to the present species in respect to the mode of growth of its colony. It is briefly described by Dr. Komai, as "No spicules. Coenenchyma and lower half of polyps covered with a thin chitinous cuticle (or perisarc)" which are the characteristics of the genus *Cornularia*. It is quite likely that this '*Cornularia*' is identical with the present new species of *Clavularia*.

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